Reliability: Beyond the Numbers
Using Key Performance Measures

By Bill Strongman, P.E.

In today’s electric utility environment, managers are expected to spend less money on maintenance and system upgrades without sacrificing reliability. At the same time, utility boards and commissions are becoming more concerned about reliability and asking tough questions.

Boards and commissions are becoming acquainted with reliability indices and are beginning to use them as key performance measures to evaluate how utilities run their businesses. But do they understand what the numbers mean?

The Numbers

The indices measure duration and frequency of customer outages on an industrywide basis. One organization, the American Public Power Association (APPA) has taken the initiative to provide its members with software and training for reporting and recording the indices. The universally recognized indices used by the APPA are shown in Figure 1. They are:

ASAI – Average system availability index.
ASAI is a measure of the overall reliability of the system. It represents the percent of time during the year that the average customer has power.

SAIDI – System average interruption duration index. SAIDI is a measure of duration. It measures the number of minutes over the year that the average customer is without power.

SAIFI – System average interruption frequency index. SAIFI is a measure of the number of times the average customer experiences an interruption in supply. For SAIFI, an interruption is a loss of supply for longer than one minute.

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\text{ASAI} = \frac{\text{customer minutes on}}{\text{total number of customer minutes per year}}
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\text{SAIDI} = \frac{\text{customer minutes out}}{\text{number of customers}}
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\text{SAIFI} = \frac{\text{customer interruptions}}{\text{number of customers}}
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Figure 1: Reliability Indices
CAIDI – Customer average interruption duration index. CAIDI is a measure of duration that provides the average amount of time a customer is without power per interruption.

An additional reliability index, SAIFI (Short), is the number of times the average customer experiences an interruption of less than one minute.

Interpreting the Numbers

Although these numbers in isolation have little meaning, they become significant when comparing a utility’s performance against industry averages, or when identifying trends. There are organizations that report outage statistics on behalf of member utilities so utilities can see how they perform against counterparts, but only a few utilities currently participate in these types of surveys. The APPA, as mentioned previously, is working toward providing this type of report for its member municipal utilities.

Even if a utility does not participate in a comparative survey, it can use the indices to identify trends in reliability, as shown in Figure 2.

The utility from which the data in Figure 2 was taken has experienced an improvement in reliability over the year shown. This type of information can be used to demonstrate to boards and commissions that the reliability initiatives undertaken by the utility are having a positive impact.

One must be cautious when using CAIDI. CAIDI, as mentioned previously, is a measure of the length of time the average customer can expect to be without power during an interruption. Some might think improved CAIDI means that the utility is doing a better job of restoring power; however, it’s more likely that improved CAIDI simply means that the utility was experiencing more short duration outages.

One might also interpret a reduction in CAIDI to be an improvement in reliability. Figure 3 demonstrates that this is not always the case. As can be seen, examining CAIDI would suggest an improvement in reliability from February to April, when in fact SAIDI and SAIFI show clearly that reliability is worsening. Both average frequency and average duration have increased. This reverses course from June to August, where SAIDI and SAIFI improved but CAIDI became worse. Why? Because CAIDI, by definition is SAIDI divided by SAIFI. Thus, if the change in SAIFI is proportionately greater than the change in SAIDI, then CAIDI will move in the opposite direction of the other two indicators.
Behind the Numbers

The real value for the manager trying to meet reliability expectations while being pressured to reduce costs is the data behind the statistics. Once the data has been captured, managers can look back and see why their reliability might be moving in the wrong direction. Figure 4 shows outages by cause. This information can help direct resources to the causes that need to be dealt with first. Figure 4 would suggest that the utility allocate more resources to upgrades and maintenance of underground equipment.

The data will also include the locations of outages. By cross-referencing location and cause, the utility can prioritize where it needs to spend its limited capital and operating dollars to improve reliability.

The utility manager can also look for trends by cause, as shown in Figure 5. This utility has experienced a significant reduction in outages caused by overhead equipment failure, but an increase in outages caused by underground equipment failure. This would suggest a trend toward more underground equipment failures.

Drawing a conclusion strictly on these numbers would be imprudent. The utility manager should look into possible causes for the change. It may be that a single anomaly such as improperly installed elbows is causing the increase in underground equipment failure. What is truly important is to know what is driving the number rather than the numbers themselves.

Although the reliability indices are important in demonstrating to boards and commissions that reliability initiatives are paying off, the real hidden gem is in the data itself. The data provides information that will help the utility manager prioritize capital and operating spending so that reliability can be improved without increasing costs.

For more information on this subject please send an email to the following address:
Bill Strongman <techbriefs@burnsmcd.com>

Bill Strongman is a senior planning engineer in Business & Technology Services. He has over 25 years experience in the electric utility industry. He has a bachelor’s degree in electrical engineering and a master’s degree in business administration, both from the University of Alberta.